

## CHAPTER 5

### CIVIL ENGINEERING

**5-1. PURPOSE.** This chapter provides guidance on the requirements for site planning and layout; roads, railroads, parking areas, drainage; and master planning.

**5-2. APPLICABILITY.** The guidance contained in this chapter will be used to ensure that consistency, uniformity, and system effectiveness are maintained throughout the design, construction, operation and maintenance, and support phases of all projects for which USAEDH has design responsibility.

#### **5-3. REFERENCE DOCUMENTS**

- a. AR 210-20, Master Planning for Army Installations
- b. TM 5-803-1, Installations Master Planning
- c. TM 5-803-5, Installation Design
- d. TM 5-822-2, General Provisions and Geometric Design for Roads, Streets, Walks, and Open Storage Areas
- e. TM 5-822-5, Pavement Design for Roads, Streets, Walks, and Open Storage Areas
- f. TM 5-850-2, Railroad Design and Construction at Army and Air Force Installations
- g. TM 5-820-4, Drainage for Areas Other Than Airfields
- h. MUTCD, Manual on Uniform Traffic Control Devices for Streets and Highways (published by the Department of Transportation)

#### **5-4. SITE PLANNING AND LAYOUT**

**a. General.** Site development is the preliminary phase of land development that requires site surveys and geotechnical investigations. In addition, layout plans are developed to allocate space for necessary facilities, buildings, utilities, parking, and landscaping. To implement site planning and layout, detailed standard civil engineering and land management practices will be applied.

**b. Objectives.** Typical plot plans furnished by USAEDH for each facility will be engineered to fit the physical characteristics of the site upon which the facility is to be constructed. Grading design will be considered in the early design stage and will take into consideration the following principal objectives:

- (1) Disposal of surface water.

- (2) Preservation of the natural terrain.
- (3) Reasonable balance of cut and fill.
- (4) Avoidance of wavy profiles in streets and walks.
- (5) Avoidance of costly erosion-control measures.
- (6) Avoidance of snow, dust, and sand drifts.
- (7) Avoidance of steps in walks.
- (8) Preservation of satisfactory ground levels so that existing trees may be saved.
- (9) Development of finished grades high enough where rock will be encountered close to the surface, thereby reducing costs of utility trenching.

**c. Government-furnished Data.** Before the A-E begins the site development, the following data will be provided by USAEDH:

- (1) Site survey showing existing topography.
- (2) Locations of existing roads, utilities, buildings, and other features.
- (3) Geotechnical information such as logs of test holes, laboratory test data and field test data; evaluation of the foundation conditions; and recommended design and construction criteria. To determine the quantity of borrow, a shrinkage or swell factor must be applied to the in situ volume to compensate for changes in unit density and loss during handling. The exact factor to be used must be determined for the particular material involved and will be furnished by USAEDH, along with any required treatment and subsequent uses of top soil material. Geotechnical data may not be available prior to the start of design; the schedule for providing this information will be discussed during prenegotiation.
- (4) Water courses, ponds, etc., and the elevation of high water.
- (5) Rock outcrops by outlines.
- (6) Data on existing trees and ground cover vegetation.
- (7) Horizontal and vertical survey control monuments for locating new construction.
- (8) Frost data.
- (9) Seismic data.
- (10) Weather data.
- (11) Photographic data, if applicable.

**d. Site Development General Criteria**

(1) The locations of buildings shown on the typical plot plans will be considered based on functional relationships to each other for operational efficiency and economical maintenance. Consideration will be given to the orientation of the buildings to take advantage of sunlight, prevailing winds, and other site features to the maximum extent possible (exposure of entrances to cold winter winds and snowdrift should be avoided). Air-conditioned and heated buildings should be oriented to expose areas to sun loads to optimize the solar effect. Energy conservation and life cycle cost design features will be reflected in the Energy Conservation and Life Cycle Cost Design Analysis specified in chapter 1.

(2) The layout of streets and railroads within the project areas will be shown on the typical plot plans for convenient, safe access and circulation. The street system provides for local traffic only and discourages through traffic. The design engineer will lay out and design access roads, railroads, parking areas, walks, and service areas for maximum effectiveness.

(3) Vehicle parking facilities will be designed for off-street parking that will be closely related to the facilities served. They will be designed for easy entrance and exit, and for safe maneuvering of vehicles. The arrangement and layout of parking spaces will be in accordance with TM 5-803-5.

(4) Sidewalks will be designed to provide convenient and safe pedestrian access and circulation within the project area. Walkway width will be based on pedestrian traffic volume. The minimum width will be four feet; this width may be increased in increments of two feet as required to accommodate the anticipated volume.

(5) The planting of grass (seeding, sodding, and sprigging) and other landscaping will be included as an integral part of the design. The cost of such landscape plantings will be a part of the cost estimate. The planting of trees and shrubs will be included in project construction only when directed by USAEDH at the beginning of design.

**e. Preparation of Design Drawings for Site Development.** Site development design submittals will be prepared in accordance with chapter 1, General Instructions, and the following detailed instructions. The design engineer will prepare the site development drawings listed below. Drawings will be prepared using engineering scales as shown in chapter 2, table 2-1, showing horizontal and vertical survey control monuments. The A-E will prepare a coordinate grid system on all plan sheets.

(1) The general site plan will consist of a complete sheet showing the project area with structures to be built as well as structure relationship to other or major existing structures.

(2) The layout plan will locate the structures, buildings, walks, railroads, roads, parking areas, planting areas, fences, and other features.

(3) The grading and drainage plan will be based on the original topographic survey, and will establish grades for structures, buildings, roads, railroads, retaining walls, ramps, and other ground surface features. The grading and drainage plan will also indicate the locations and

grades of required surface drainage structures, or subsurface drainage facilities. The locations of soil borings will be shown on this plan.

(4) The utility plan will identify and locate water lines, sanitary sewer lines, force mains, industrial waste lines, and other subsurface utility features.

(5) Construction details will be shown on the plans. All sections, elevations, and profiles needed to provide construction details for all elements of the layout and grading and drainage plans, including roads, walks, railroads, steps, walls, curbs, gutters, drain inlets, paving sections, fences, utilities, and other features will be shown.

(6) The planting plan will locate and identify items of plant material to be used and existing materials to be preserved or removed. A plant list including quantities, sizes, and varieties of plants will be included. The A-E will prepare this plan only when directed by USAEDH at the beginning of design.

## **5-5. ROADS, RAILROADS, PARKING AREAS, AND DRAINAGE**

**a. General.** Roads and parking area pavement will consist of a subbase course, base course, and a flexible or rigid pavement surface course. Surfacing will be hot-mix bituminous concrete surface course where it is assured that hot-mix plants will be operating on or within hauling distance of an installation during paving operations. Curbs, combination curbs and gutters, or shallow paved gutters, and attendant underground storm drains will be constructed along streets and around off-street parking areas in built-over areas. They will not be constructed along roads and at remote facilities except as required for drainage and erosion control.

In some cases subgrade stabilization may be economically warranted for flexible and rigid pavements. For flexible pavement, stabilization of subgrade is to increase the California Bearing Ratio (CBR) value in lieu of increasing thickness of the base to conform to design curves. The stabilization for rigid pavements is not to increase the K value of the soil, but to provide a surface suitable for operation of construction equipment. If uniform stabilization is not specified, severe disturbance and spot stabilization necessary during construction will result in a non-uniform subgrade detrimental to this type pavement. In areas containing relatively stable material near the surface, stabilization of subgrade should not be necessary. Roadway traffic control signs and markings will be designed in accordance with the "Manual on Uniform Traffic Control Devices for Streets and Highways."

**b. Reference Documents.** Comprehensive outlines of basic design principles for this work are provided in TM 5-822-2, TM 5-822-5, TM 5-850-2, and TM 5-820-4.

**c. Pavement Design.** Pavement structural design will be furnished by USAEDH. This will include class, category, design index, CBR, modulus of subgrade reactions (K), concrete flexural strength, and the type of thickness of the various component layers adopted for construction. Subsurface surveys will be furnished by USAEDH.

**d. Plans and Profile.** In all designs, simplicity and economy are desired. As an example, only those typical sections that are necessary to specify the paving section will be shown. Finished surface grades for the pavement on parking areas and other large paved areas will be shown by contours, usually at an interval of 0.3048 meters (0.1 foot). A contour interval of 0.3048 meters (1.0 foot) is usual for graded areas. Plans and profile will be shown for all

roads and railroads, preferably with the profile shown directly under the plan. A sufficient number of typical cross sections will be shown for roads, railroads, and parking areas to clearly indicate the construction to be performed. For roads or railroads of any considerable length, cross sections will be plotted at minimum intervals of 30.48 meters (100 feet) for computing quantities of earthwork. These cross sections and all earthwork calculations will be furnished to USAEDH along with prefinal plans to facilitate checking earthwork quantities.

**e. Drainage Pipes.** It is the policy of USAEDH, in the preparation of contract plans and specifications, to allow the construction contractor an option of materials for drainage pipes. Size selection should be based on individual design calculations using Manning "N" values specified in TM 5-820-4. These calculations will be shown in the design analysis. Strength requirements for the various sizes of pipe will be indicated on the plans. A format for this will be furnished by USAEDH.

**f. Drainage Design Analysis.** A complete design analysis for drainage features is required as a part of each design submittal. The design analysis will indicate the formulas and assumptions as well as references to any textbook tables used to determine pipe sizes and other important features of the design. A print of the area involved will be furnished with the design analysis showing the individual drainage areas used in the design. These may be outlined in red pencil on a print showing the drainage system if desired.

**g. Pavement Design Analysis.** A brief design analysis will be prepared, based on USAEDH-furnished designs, for all paving features. In the case of flexible pavement, it will consist of the class, category, index, CBR of the subgrade, the type, and thickness of the various component layers and a typical cross section adopted for construction. In the case of portland cement concrete pavement, the modulus of subgrade reaction, class, category, index, the 28-day flexural strength of the concrete, the total thickness, and a typical cross section adopted for construction will be given. These items will be coordinated with USAEDH prior to the concept submittal for review.

## **5-6. MASTER PLANS**

**a. General.** Master plans are drawings and plans that depict actual installation configuration and development. Elements of master plans include basic information maps; analysis of existing facilities/environmental report; building information schedule; future development plans; analytical/environmental assessment report; tabulation of existing and required facilities; and capability plans.

**b. Scope.** Development of master plans is applicable to the US Army Corps of Engineers and all commands and activities involved in the preparation and maintenance of master plans. Army Regulation 210-20 requires that all Army installations, with permanent construction requirements, have master plans prepared and maintained to facilitate installation and development in a manner that will lead to effective fulfillment of Army missions at minimum cost.

**c. Reference Documents.** Master planning reference documents are shown in AR 210-20 and TM 5-803-1.